REMARKS/ARGUMENTS

In printing the specification, a word processor error changed the symbol µ (Greek letter "mu") to the letter "m". The above amendments to the specification and claims correct the error. A person of ordinary skill in the art of friction materials, would readily recognize that 5mm, i.e., 1/2 cm is an absurdly large protrusion diameter in the context of a friction mating member. Moreover, the discussion in paragraph 0038, stating that comparative example 3 had too high a base member surface roughness, when considered together with the 1.0 µm figure given in FIG. 5 and the expressed preference for a "0.07 mm" maximum base member surface roughness in paragraph 0026, makes it clear that the use of mm is erroneous, and that it should be µm instead. Finally the expression "m-V" for the relationship between friction coefficient and speed should obviously have been "µ-V", the symbol µ being a standard symbol for the coefficient of friction (Machinery's Handbook, 15th Edition, 1954, pp. 516, copy enclosed). In short, the erroneous use of m for µ would have been recognized by a person skilled in the art, and its correction does not introduce new matter.

Claim 1 has been amended by incorporating in it the substance of claims 2 and 3. Claims that are directly or indirectly dependent on claim 2 or claim 3 have been cancelled. Claim 1, the only independent claim now in the application, is now directed to a friction member having the following features:

(A) a hard coating in which the elastic range[1] is at least 50%;

(B) a surface roughness in the range of 4 to 50 nm (excluding the semispherical protrusions); and

(C) semispherical protrusions having diameters of 1 to 5 µm on the outer surface of the hard coating;

(D) the protrusions occupying at least 3% of the area of the outer surface of the hard coating; and

(F) the arithmetic average surface roughness Ra of the base member not greater than 0.07 µm.

As shown in FIG. 5, only in the example having the combination of features A, B, D, and F, does the coefficient of friction increase monotonically with speed. This results in a superior shudder-suppressing effect, as shown in FIG. 6.

Comparative Example 1 is the TiN coated clutch separator plate of Yesnik, which corresponds to JP 272517/1992, cited in paragraph 0008. This example has an elastic range less than 50%, and no protrusions, and exhibits a high friction coefficient in the low speed range, and a relatively high degree of shudder, compared with the example in accordance with the invention.

Kataoka teaches the use of projections on the surface of a clutch plate to establish a "respiration" effect by which oil is drawn into the clearances between surfaces (Kataoka column 5, lines 45-57), and a vibration buffering effect due to vibration of the projections 13. (Kataoka, column 5, line 64 - column 6, line 6). Kataoka does not teach how to

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[1]A shorthand expression for the ratio of elastic deformation to maximum indentation depth, in a load range of 1 to 50 mN (See paragraph. 0022)

maintain a positive gradient in the μ-V curve, using protrusions. Even if Yesnik's clutch separator plate were provided with protrusions such as those of Kataoka, the result would not have a hard coating with an elastic range of at least 50% (Feature A). Moreover, neither patent suggests the specific combination of features A-F listed above and recited in claim 1, as amended.

Accordingly, the references do not demonstrate obviousness of the invention as now defined in claim 1, as amended, and claim 1, and the remaining dependent claims should be found allowable. The applicants respectfully request favorable reconsideration and the issuance of a notice of allowance.

Respectfully submitted,
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Enclosure:
title page and page 515
from "Machinery's Handbook"

MACHINERY'S HANDBOOK

FOR MACHINE SHOP AND DRAFTING-ROOM

A REFERENCE BOOK ON MACHINE DESIGN AND SHOP PRACTICE FOR THE MECHANICAL ENGINEER, DRAFTSMAN, TOOLMAKER, AND MACHINIST

BY

ERIK OBERG AND F. D. JONES

FIFTEENTH EDITION

HOLBROOK L. HORTON, Editor

THE INDUSTRIAL PRESS
148 Lafayette Street, New York 13, N. Y.

Sole Distributors for the British Empire:
MACHINERY PUBLISHING CO., LTD.
National House, West St., Brighton 1, England

1954

Hollow and Solid

:rength; lower figures

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48	50.29	80.56
29	70.91	89.75
01	40.96	65.61
00	64.00	81.00
40	27.98	44.82
48	52.89	66.94
58	19.76	31.65
02	44.44	56.25
41	14.35	23.98
99	37.87	47.93
25	10.67	17.08
00	32.66	41.33
75	8.09	12.96
77	28.45	36.00
68	6.25	10.02
14	25.00	31.64

FRICTION

Friction is the resistance to motion which takes place when one body is moved upon another, and is generally defined as "that force which acts between two bodies at their surface of contact, so as to resist their sliding on each other." The force of friction, F, bears — according to the conditions under which sliding occurs — a certain relation to the pressure between the two bodies; this pressure is called the normal pressure N. The relation between force of friction and normal pressure is given by the *coefficient of friction*, generally denoted by the Greek letter μ. Thus:

$$F = \mu \times N, \quad \text{and} \quad \mu = \frac{F}{N}$$

Example: — A body weighing 28 pounds rests on a horizontal surface. The force required to keep it in motion along the surface is 7 pounds. Find the coefficient of friction.

$$\mu = \frac{F}{N} = \frac{7}{28} = 0.25$$

If a body is placed on an inclined plane, the friction between the body and the plane will prevent it from sliding down the inclined surface, provided the angle of the plane with the horizontal is not too great. There will be a certain angle, however, at which the body will just barely be able to remain stationary, the frictional resistance being very nearly overcome by the tendency of the body to slide down. This angle is termed the angle of repose, and the tangent of this angle equals the coefficient of friction. The angle of repose is frequently denoted by the Greek letter θ. Thus, $\mu = \tan\theta$.

A greater force is required to start a body from a state of rest than to merely keep it in motion, because the *friction of rest* is greater than the *friction of motion*.

Rolling Friction. — When a body rolls on a surface, the force resisting the motion is termed *rolling friction*. This has a different value from that of the ordinary, or sliding, friction. Let W = total weight of rolling body or load on wheel, in pounds; r = radius of wheel, in feet; f = coefficient of rolling friction. Then:

$$\text{Resistance to rolling, in pounds} = \frac{W \times f}{r}$$

The coefficient of rolling friction varies with the conditions. For wood on wood it may be assumed as 0.005; for iron on iron, from 0.002 to 0.005; iron on granite, 0.007; iron on asphalt, 0.012; iron on wood, 0.018.

Laws of Friction. — The earliest experiments made on friction, which led to the establishment of definite laws, were undertaken by Morin and Rennie about 1830. The laws laid down by these early investigators, however, have been considerably modified by later investigations. The following may be considered as a correct statement of the laws of friction in their modified form, for unlubricated or dry surfaces.

1. For low pressures the friction is directly proportional to the normal pressure between the two surfaces. As the pressure increases to a high value the friction does not rise as rapidly; but when the pressure becomes abnormally high, the friction increases at a rapid rate until seizing takes place.
2. The friction both in its total amount and its coefficient is independent of the areas in contact, so long as the total pressure remains the same. This is true for moderate pressures only. For high pressures, this law is modified in the same way as in the first case.
3. At very low velocities the friction is independent of the velocity of rubbing. As the velocities increase, the friction decreases.